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Innovating standards through informal consortia: The case of wireless telecommunications ☆

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ABSTRACT

We empirically examine the effects of industry consortia on the coordination of innovation strategies of the members. Our analyses utilize membership data from 32 consortia in wireless telecommunication technology subfields from 2000 to 2005 and prior art citations in standard-essential patents. We find that connections among firms in informal and technically-oriented consortia significantly increase the likelihood that firms cite each other's patents in subsequent patents essential for the UMTS wireless telecommunication standard. Inventions that are likely to become part of the UMTS system tend to build on inventions by firm peers who were members of the same consortia, controlling for patent or firm fixed effects, technology class, and other characteristics. Consortia may enhance productivity of invention and increase the incentives to invest in R&D by internalizing potential externalities. They may also enhance efficiency of standardization by facilitating the interaction of committee and market processes. Consortia thus structure and constrain the process of innovating standardized technologies. This is problematic if consortia are not truly accessible for all the relevant parties. Policymakers thus need to balance these effects. For managers, the results show that participation in a variety of technical consortia enables influencing peers' innovation strategies related to compatibility standards.

1. Introduction

This paper examines the effects of firms' participation in wireless telecommunications industry consortia on their subsequent inventions that become declared essential patents in the global UMTS standard for mobile communication. We highlight the increasingly central role that these types of technical consortia play in coordinating technology development in many different technology fields and industries. Consortia are particularly prevalent in, but not limited to, Information and Communication Technology (ICT) industries where individual products may be associated with thousands of patents and hundreds of compatibility standards (Biddle, 2012; WSJ, 2011).

Compatibility standards are common technology norms that ensure interoperability between communication products and services.[1] Information and Communication Technology (ICT) standards, in particular, embody an increasing number of patented elements. In many ICT fields, particularly in telecommunications, standards have traditionally been defined cooperatively by governments or industry actors within formal Standard Setting Organizations[2] (SSOs). However, these formal SSOs are often perceived to be slow and bureaucratic, particularly when intellectual property rights have become part of the negotiation (Simcoe, 2012; Bekkers et al. 2002.). For instance, the 3G wireless telecom standard studied here is associated with around 16,000 essential patent disclosures, and its development took most of a decade.

To accelerate the process, sub-groups of firms may create less formal upstream alliances or consortia. These types of collaborative organizations offer opportunities to discuss, test, or promote certain technologies, or they can be used to actually develop new technical specifications that will subsequently be submitted to formal SSOs for official approval. The effects of these consortia have been debated in policy circles (e.g., Cargill, 2001) but there is little quantitative empirical research evidence. DeLacey et al. (2006) discuss the division of labor between formal standardization and informal consortia in the development of WiFi and DSL standards, noting that firms may use consortia to influence and accelerate formal standardization. Leiponen (2008) suggests that ICT firms' participation in such consortia enhances their ability to influence formal standard-setting outcomes. However, there is no evidence to date about the broader implications of consortia for

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[1] E.g., mobile phones, DVD content and players, and internet protocols.

[2] E.g., International Standard Organization, International Telecommunication Union.

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coordination of innovation in network-technological industries. The purpose of this paper is to address this research gap and conduct an empirical analysis of the effects of ICT consortia on the coordination of R&D strategies of the participants.

Whether consortia facilitate the coordination of innovation related to communication standards is interesting from both policy and managerial perspectives. From a policy standpoint, our results may inform competition policy. The economic literature (Choi, 1993; Jorde and Teece, 1990; Katz and Ordover, 1990) often considers collaborative industry organizations as a potential threat to competition because of excessive market coordination. However, consortia can be socially desirable if they reduce coordination problems around innovation. In this case, consortia might mitigate wasteful duplication of effort and increase incentives to invest in R&D by internalizing externalities (d'Aspremont and Jacquemin, 1988). These arguments could lead competition authorities to adopt a lenient policy with respect to standardization consortia, because they might, overall, increase R&D efforts and productivity.

Our analyses of industry consortia in wireless telecommunications shed new light on the process through which communication standards are being created. Development of "open standards" through a process that is not truly accessible for all the interested parties may be viewed as problematic. To the degree that essential inventions that become incorporated in the formal standard are coordinated and agreed in informal and semi-private consortia, policymakers may find it worthwhile to better understand and provide rules of the game regarding meeting procedures, membership fees particularly for small firms, terms of access, and public release of relevant information. Indeed, if consortia are used to coordinate innovation in advance of formal standard setting, there is a trade-off between the speed of development and representation of the different stakeholders. Monopolization of key technologies underpinning a widely used standard is likely to lead to excessive royalties and potential holdup that can slow down technology adoption and reduce social welfare. This would be equivalent to monopolization of an upstream market in a long and complex value chain.

From a strategic viewpoint, participation in standardization consortia may offer a venue for firms to promote their technologies and become central and powerful players in an innovation network (Ballester et al., 2006; Fershtman and Gandal, 2011). For instance, from a sociological perspective, Pfeffer (1981) suggests that consortium participation helps firms to access and control strategic knowledge. Nevertheless, there is little empirical evidence for this assertion. Our research aims to highlight strategies that firms may deploy to influence innovation by others — particularly innovation related to compatibility standards.

This paper utilizes a network-analytical approach that examines the effects of one-mode and two-mode network connections on subsequent patent citations. A study of two-mode networks in open-source software development by Fershtman and Gandal (2011) is closely related to ours. We combine membership data from 32 ICT consortia to identify consortium network ties between firms involved in formal standardization of wireless telecommunication technologies through Third Generation Partnership Project, or 3GPP. 3GPP is the international standard-setting organization driving the specification development for the Universal Mobile Telecommunication System, UMTS, which is one of the third-generation mobile communication systems. Additionally, we compile and analyze citations of 16,000 essential patents filed by member firms in the 3GPP standardization process for UMTS. These data will be used to econometrically assess the effects of firms' participation in consortia on cross-citations of subsequent inventions. To empirically identify the causal relationship, we use a merger in the network of consortia as an exogenous event that changed the consortium connections of dozens of member firms.

According to our empirical analysis, patent holders' involvement in consortia increases the likelihood that their patents are cited by other consortium members in subsequent patents that are declared essential for the UMTS standard. This result is particularly strong for consortia that are technically oriented (as opposed to marketing oriented) or formally allied with and thus directly related to 3GPP. The result is significant only for informal consortia and does not hold for more formal organizations such as other formal standard-setting organizations (e.g., regional SSOs). It also does not hold for other patents than those subsequently declared essential for the UMTS standard. The significant relationship we find thus appears to involve informal technical consortia and patents closely related to a standard. Finally, a change in the consortium network caused by a merger of several consortia had a significant impact on the strength of this coordination effect. Our main results are supported by a difference-in-differences analysis utilizing this source of exogenous variation.

Our results highlight informal technical consortia as an organization form that enables sharing of knowledge and coordination of R&D efforts related to compatibility standards in network industries. The remainder of this paper is organized as follows. Section 2 reviews the literature on consortia and discusses the conceptual foundations of our research. Section 3 explains the data collection process and the empirical methodology. Section 4 presents our empirical results and Section 5 concludes.

2. Earlier literature on technical consortia and the intended empirical contribution

Research and development consortia have been studied extensively in various strands of literature. The advantages and drawbacks of these organizations as well as their formation process and possible impact on future alliances are now relatively well understood. Here, we will review the benefits and costs of participation as discussed in earlier studies, and finish by discussing the distinct features and implications of consortia focused on standardization rather than just R&D.

Scholars have found substantial positive effects of consortium participation on innovation by firms. For instance, an early stream of research analyzes R&D consortia from a theoretical standpoint and underlines financial incentives to participate. Katz (1986), Katz and Ordover (1990), and d'Aspremont and Jacquemin (1988) view consortia primarily as a means to share and reduce R&D expenses. Consortia may enable scale economies and reduce effort duplication among participants. Subsequent studies examine the incentives to participate when firms have asymmetric contributions (e.g., Kamien et al., 1992). Here, R&D investments create knowledge spillovers. Spillovers are positive externalities that enhance the social benefits of R&D investments, but they lead to socially suboptimal investments because private incentives do not take spillovers into account. Consortia may enable the internalization of these spillovers. This positive effect has led some scholars to propose public funding of R&D consortia (Romer and Griliches, 1993).

Two empirical papers confirm that R&D consortia lead to increased R&D investments and productivity. First, Branstetter and Sakakibara (1998) analyze a sample of Japanese consortia and find that the marginal effect of consortium participation is about two percent increase in total R&D spending and between four and eight percent increase in patenting per R&D dollar (research productivity). In a subsequent paper, Sakakibara (2001) finds an even more substantial effect of consortium participation on R&D expenditures (around 9%) and also finds support for the hypothesis that diverse competencies of members enhance the efficiency of the consortium, thus leading to greater R&D expenditures by participants (see also Chung et al., 2000).

An organization-theoretic literature suggests that participation in R&D consortia facilitates obtaining a strategic advantage over competitors. Pfeffer (1981) proposes that consortium participation helps firms to access and control strategic knowledge. Aldrich et al. (1998) also argue that R&D consortia could help to orient research in the industry in a way that supports the firm's strategy. This hypothesis is empirically supported by Leiponen (2008) who examines consortia around the Third Generation Partnership Project (3GPP), a formal standards-development organization. That study finds that participation in technical consortia significantly enhances firms' contributions to new standard